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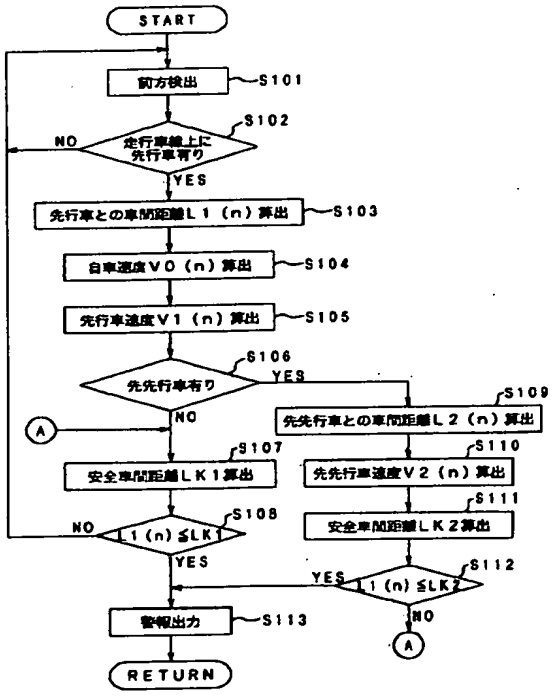
(54)【発明の名称】　車両の衝突防止装置

(57)【要約】
【課題】　先行車や先行車前方の先先行車等の複数の障害物を考慮した総合的な安全性を確保し、衝突の危険を未然に回避させる。
【解決手段】　走行車線上に先行車が存在し、さらに、先行車前方に先先行車が存在する場合、自車と先先行車との車間距離Ｌ2(n)を算出し、さらに、この車間距離Ｌ2(n)の時間変化、及び、現在の自車速度Ｖ0(n)に基づいて先先行車速度Ｖ2(n)を算出する。そして、先先行車の存在を考慮した自車と先行車との安全車間距離ＬＫ2を算出し、この安全車間距離ＬＫ2と現在の車間距離Ｌ1(n)とを比較し、Ｌ1(n)≦ＬＫ2のとき、警報信号を出力してドライバに警告を発する。すなわち、先行車のドライバが先先行車との車間距離を十分取らずに先先行車に異常接近し、急ブレーキをかける、あるいは、衝突寸前でハンドル操作により衝突を回避するような事態を予想して予め安全な車間距離を取らせ、思わぬ事故を未然に回避する。



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【特許請求の範囲】

【請求項１】　自車両の進行方向に存在する先行車と自車両との車間距離を算出する手段と、
上記先行車と上記先行車の前方状況とを考慮して自車両と上記先行車との安全車間距離を算出する手段と、
上記車間距離と上記安全車間距離とを比較し、自車両の衝突可能性を判断する手段とを備えたことを特徴とする車両の衝突防止装置。

【請求項２】　上記安全車間距離を、自車両と上記先行車の前方に存在する物体との距離を基本として算出することを特徴とする請求項１記載の車両の衝突防止装置。

【請求項３】　上記安全車間距離を、上記先行車の前方状況に対する危険認識の遅れによる空走時間を想定して算出することを特徴とする請求項１記載の車両の衝突防止装置。

【請求項４】　上記安全車間距離を、上記先行車の加速状態に応じて算出することを特徴とする請求項１記載の車両の衝突防止装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、自車両の進行路上に存在する障害物を検出して衝突判断を行う車両の衝突防止装置に関する。

【０００２】

【従来の技術】最近では、自動車にＴＶカメラやレーザ・レーダ等を搭載して前方の車両や障害物を検知し、それらに衝突する危険度を判定して運転者に警報を発したり、自動的にブレーキを作動させて停止させる、あるいは、先行車との車間距離を安全に保つよう自動的に走行速度を増減する等のＡＳＶ（Advanced Safety Vehicle；先進安全自動車）に係わる技術の開発が積極的に進められている。

【０００３】このようなＡＳＶにおける衝突防止装置の例としては、自動車技術Vol. 43, No. 2, 1989. P. 65～P. 73「大型トラック用追突防止警報装置」に、自車両の車速とレーザ・レーダ装置により検出した自車両と先行車両との車間距離を基に、先行車速度、自車両と先行車両との相対速度等を算出し、この相対速度によって自車両速度を基にして算出する安全車間距離を切り換え、上記車間距離が上記安全車間距離を割り込んだときに追突の危険性があるとして警報を発する技術が開示されている。

【０００４】

【発明が解決しようとする課題】しかしながら、従来は、上記先行技術のように自車両前方の先行車や障害物のみを考慮して危険性の判断を行っており、先行車の更に前方の状況が考慮されていない。

【０００５】このため絶対的な安全性を考慮し、先行車が停止物に衝突するなど極端な急停止を行う場合を想定すると、常に非常に大きな車間距離で警報を発する必要があり、運転者に非常に大きな車間距離を要求することから滑らかな交通の妨げとなる等の問題がある。

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【０００６】また、常に先行車が妥当性を持った挙動をとることを前提にして警報の発生を行うと、運転者の先行車の挙動のみに注視した思い込み等に対しては、それ以上の安全性の向上を図ることが出来ないという問題がある。

【０００７】本発明は上記事情に鑑みてなされたもので、先行車や先行車前方の先先行車等の複数の障害物を考慮した総合的な状況の判断を行うことにより、衝突の危険を未然に回避させた上に運転者の違和感を排除し、さらに、交通の流れの妨げとならない車両運行を行うことができる車両の衝突防止装置を提供することを目的としている。

【０００８】

【課題を解決するための手段】請求項１記載の発明は、自車両の進行方向に存在する先行車と自車両との車間距離を算出する手段と、上記先行車と上記先行車の前方状況とを考慮して自車両と上記先行車との安全車間距離を算出する手段と、上記車間距離と上記安全車間距離とを比較し、自車両の衝突可能性を判断する手段とを備えたことを特徴とする。

【０００９】請求項２記載の発明は、請求項１記載の発明において、上記安全車間距離を、自車両と上記先行車の前方に存在する物体との距離を基本として算出することを特徴とする。

【００１０】請求項３記載の発明は、請求項１記載の発明において、上記安全車間距離を、上記先行車の前方状況に対する危険認識の遅れによる空走時間を想定して算出することを特徴とする。

【００１１】請求項４記載の発明は、請求項１記載の発明において、上記安全車間距離を、上記先行車の加速状態に応じて算出することを特徴とする。

【００１２】すなわち、自車両の進行方向に存在する先行車と自車両との車間距離を算出し、この車間距離を、先行車と先行車の前方状況とを考慮して算出した自車両と先行車との安全車間距離と比較して自車両の衝突可能性を判断する。

【００１３】その際、安全車間距離を自車両と先行車の前方に存在する物体との距離を基本として算出しても良く、また、先行車の前方状況に対する危険認識の遅れによる空走時間を想定して算出しても良い。さらには、先行車の加速状態に応じて安全車間距離を算出しても良い。

【００１４】

【発明の実施の形態】以下、図面を参照して本発明の実施の形態を説明する。図１～図４は本発明の実施の第１形態に係わり、図１は衝突防止装置の概略構成図、図２は衝突防止装置の回路ブロック図、図３は衝突防止処理のフローチャート、図４は先先行車と先行車と自車との関係を示す説明図である。

【００１５】図１において、符号１は自動車等の車両であり、この車両１に、進行方向に存在する障害物、先行車両、この先行車両の前方に存在する先先行車両等を認識して衝突の危険性を判断し、衝突の危険性がある場合、衝突回避の警報を発して安全を確保する衝突防止装置２が搭載されている。

【００１６】上記衝突防止装置２には、車外の対象物を異なる位置から撮像するためのステレオ光学系１０、このステレオ光学系１０で撮像した１対の画像を処理し、同一物体に対する視差から三角測量の原理により画像全体に渡る３次元の距離分布を算出する（いわゆるステレオ法による）イメージプロセッサ２０、このイメージプロセッサ２０からの距離分布データを処理して道路形状や複数の立体物を認識し、先行車や先行車前方の先先行車等の複数の障害物に対する安全性を総合的に判断して衝突の危険性がある場合には衝突警報を出力する画像処理・衝突防止処理用コンピュータ３０が備えられ、上記画像処理・衝突防止処理用コンピュータ３０に、車速センサ３等の現在の車両の走行状態を検出するためのセンサが接続されるとともに、ブザーあるいはディスプレイ等からなる警報装置４が接続されている。

【００１７】図２に示すように、上記ステレオ光学系１０は、例えば電荷結合素子（ＣＣＤ）等の固体撮像素子を用いた左右１組のＣＣＤカメラ１０ａ，１０ｂによって構成されており、これらのカメラ１０ａ，１０ｂは、先行車の前方認識が容易となるよう、図１に示すように、例えば車両１のルーフ上の前方に設置され、自車前方のみならず先行車の更に前方まで撮像視野を拡大するようになっている。

【００１８】また、上記イメージプロセッサ２０は、上記ステレオ光学系１０で撮像した２枚のステレオ画像対に対して微小領域毎に同一の物体が写っている部分を探索し、対応する位置のずれ量を求めて物体までの距離を算出する距離検出回路２０ａと、この距離検出回路２０ａの出力である画像のような形態をした距離分布データ（距離画像）を記憶する距離画像メモリ２０ｂとから構成されている。

【００１９】さらに、上記画像処理・衝突防止処理用コンピュータ３０は、主として道路形状を検出する処理を行なうマイクロプロセッサ３０ａと、主として個々の立体物を検出する処理を行なうマイクロプロセッサ３０ｂと、主として、自車と先行車との車間距離から衝突危険性を判断するマイクロプロセッサ３０ｃとがシステムバス３１を介して並列に接続されたマルチマイクロプロセッサのシステム構成となっている。

【００２０】上記システムバス３１には、上記距離画像メモリ２０ｂに接続されるインターフェース回路３２、制御プログラムを格納するＲＯＭ３３、計算処理途中の各種パラメータを記憶するＲＡＭ３４、上記車速センサ３及び上記警報装置４が接続されるＩ／Ｏインターフェース回路３５、処理結果のパラメータを記憶する出力用メモリ３６等が接続されている。

【００２１】上記マイクロプロセッサ３０ａによる道路検出処理では、距離画像メモリ２０ｂに記憶された距離画像による３次元的な位置情報を利用して実際の道路上の白線だけを分離して抽出し、内蔵した道路モデルのパラメータを実際の道路形状と合致するよう修正・変更して道路形状を認識する。

【００２２】また、上記マイクロプロセッサ３０ｂによる物体検出処理では、距離画像を格子状に所定の間隔で区分し、各領域毎に、走行の障害となる可能性のある立体物のデータのみを選別して、その検出距離を算出し、隣接する領域において物体までの検出距離の差異が設定値以下の場合は同一の物体と見なし、一方、設定値以上の場合は別々の物体と見なし、検出した物体の輪郭像を抽出する。

【００２３】尚、以上のイメージプロセッサ２０による距離画像の生成、上記マイクロプロセッサ３０ａ，３０ｂによる距離画像から道路形状や物体を検出する処理については、本出願人によって先に提出された特開平５－２６５５４７号公報や特開平６－１７７２３６号公報等に詳述されている。

【００２４】また、上記マイクロプロセッサ３０ｃによる衝突防止処理では、自車と先行車との安全車間距離を算出し、自車と先行車との車間距離が安全車間距離以下になったとき、警報装置４に警報を出力する通常の処理に加え、先行車の前方に先先行車が存在する場合、自車と先先行車との車間距離や相対速度を考慮して自車と先行車との安全車間距離を算出し、自車と先行車との車間距離が安全車間距離以下になったとき、警報装置４に警報を出力してドライバに警告を発し、図示しないブレーキの操作を促すことで、先先行車の存在による先行車の急激な挙動変化に対する安全性を確保する。尚、図示しない自動ブレーキ装置等と連動させ、作動信号を出力することも可能である。

【００２５】以下、上記画像処理・衝突防止処理用コンピュータ３０による処理のうち、本発明に係わる衝突防止処理を図３のフローチャートに従って説明する。尚、以下の説明においては、自車、自車前方を走行する先行車、この先行車の更に前方を走行する先先行車の関係について説明するが、先先行車は、駐車車両、横断中の歩行者等のように必ずしも走行車両でなくとも良い。

【００２６】このプログラムでは、まず、ステップS101で、自車の走行方向を撮像して得られる距離画像から抽出された複数の立体物のデータを読み込み、ステップS102で、走行車線上に先行車が有るか否かを調べる。その結果、走行線上に先行車が無い場合には上記ステップS101へ戻り、走行車線上に先行車が有る場合、ステップS103へ進んで、先行車と自車との車間距離Ｌ1(n)を算出する。尚、今まで記憶していた値は前回の車間距離Ｌ1(n-

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1)として記憶更新する。以下、各パラメータにの添え字(n)は今回求めた値を表し、添え字(n-1)は前回求めた値を表す。

【００２７】次に、ステップS104へ進み、車速センサ３からの信号に基づいて自車速度Ｖ0を算出し、ステップS＊

$$V1(n)=(L1(n)-L1(n-1))/\Delta t+V0(n) \quad \cdots(1)$$

但し、Δｔ：計測、演算周期

その後、ステップS106へ進み、距離画像から抽出された複数の立体物のデータから先行車の前方に先先行車が存在するか否かを調べる。その結果、先先行車が存在しないときには、上記ステップS106からステップS107へ進み、先行車と自車との安全車間距離ＬＫ1を算出する。

【００２９】この安全車間距離ＬＫ1は、先行車が速度 ※

$$LK1=-V1(n)^2/(2\cdot\alpha k11)+(V0(n)^2/(2\cdot\alpha k0)+V0(n)\cdot T1+L0) \quad \cdots(2)$$

但し、Ｔ1：自車の空走時間

Ｌ0：距離マージン（停止後の間隔）

ここで、上記(2)式における先行車の制動距離を定める減速度αk11の値は、例えば、先行車が急ブレーキを掛けた状態を想定して予め設定しておき、また、自車の制動距離を定める減速度αk0の値は、自車の制動能力等を考慮して設定される。また、ドライバの反応時間を考慮した空走時間Ｔ1に対し、車間距離の余裕となる距離マージンＬ0の値は、例えば、先行車の加速度に応じて設定しても良く、先行車の加速度が負で減速状態にあるときには、先行車の減速度が大きい程、距離マージンＬ0を大きく取ることが望ましい。

【００３１】そして、上記ステップS107で安全車間距離ＬＫ1を算出すると、ステップS108へ進み、この安全車間距離ＬＫ1と現在の車間距離Ｌ1(n)とを比較する。そ ★

$$V2(n)=(L2(n)-L2(n-1))/\Delta t+V0(n) \quad \cdots(3)$$

その後、ステップS111へ進み、先先行車の存在を考慮した自車と先行車との安全車間距離ＬＫ2を算出する。すなわち、図４に示すように、自車１の前方に先行車５０が存在し、さらに、この先行車５０の前方に先先行車１００が存在するような状況で、先行車５０のドライバが先先行車１００との車間距離を十分取らずに先先行車１００に異常接近し、急ブレーキをかける、あるいは、衝突寸前でハンドル操作により衝突を回避したような場合☆

$$LK2=-V2(n)^2/(2\cdot\alpha k2)+(V0(n)^2/(2\cdot\alpha k0)+V0(n)\cdot T1+L0+C1 \quad \cdots(4)$$

但し、Ｃ1：先行車の車体長

この場合、上記(4)式における制動距離“$V2(n)^2/(2\cdot\alpha k2)$”の項は、先行車の前方に検出した物体が走行車両でなく駐車車両や歩行者等のときには０となり、“$(V0(n)^2/(2\cdot\alpha k0)+V0(n)\cdot T1+L0+C1$”の項が自車から先行車前方の物体までの距離Ｌ2(n)以下となるよう、現在の自車速度Ｖ0(n)に応じて自車の減速度αk2が設定される。

【００３５】次いで、上記ステップS111からステップS1

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＊105で、今回の車間距離Ｌ1(n)と前回の車間距離Ｌ1(n-1)との時間変化、及び、現在の自車速度Ｖ0(n)に基づいて先行車速度Ｖ1(n)を以下の(1)式で算出する。

【００２８】

※Ｖ1(n)から減速度（負の加速度；但し、以下、特記しない限り絶対値を示す）αk11で制動を加えたと仮定した場合の制動距離“$V1(n)^2/(2\cdot\alpha k11)$”と、自車が速度Ｖ0から減速度αk0で制動したときの制動距離“$(V0(n)^2/(2\cdot\alpha k0)$”とに基づいて、以下の(2)式で算出される。

【００３０】

★の結果、現在の車間距離Ｌ1(n)が安全車間距離ＬＫ1より大きいときには上記ステップS108から前述のステップS101へ戻り、現在の車間距離Ｌ1(n)が安全車間距離ＬＫ1以下であるとき、衝突の危険性有りと判断し、ドライバに警告を発して図示しないブレーキの操作を促すべく上記ステップS108からステップS113へ進んで警報装置４に警報信号を出力し、ルーチンを抜ける。

【００３２】一方、上記ステップS106で、先先行車が存在するときには、上記ステップS106からステップS109へ分岐し、自車と先先行車との車間距離Ｌ2(n)を算出すると、ステップS110で、今回の車間距離Ｌ2(n)と前回の車間距離Ｌ2(n-1)との時間変化、及び、現在の自車速度Ｖ0(n)に基づいて先先行車速度Ｖ2(n)を以下の(3)式で算出する。

【００３３】

☆を想定し、前述の(2)式による自車と先行車との安全車間距離ＬＫ1に対し、先行車５０の速度Ｖ1(n)からの減速度αk11による制動距離“$V1(n)^2/(2\cdot\alpha k11)$”を、先先行車１００の速度Ｖ2(n)からの減速度αk2による制動距離“$V2(n)^2/(2\cdot\alpha k2)$”に置き換え、先先行車１００が存在する場合の自車１と先行車５０との安全車間距離ＬＫ2を以下の(4)式で算出する。

【００３４】

12へ進んで先先行車が存在する場合の安全車間距離ＬＫ2と現在の車間距離Ｌ1(n)とを比較し、現在の車間距離Ｌ1(n)が安全車間距離ＬＫ2より大きいときには、前述のステップS107へジャンプして先先行車が存在しない場合の安全車間距離ＬＫ1と現在の車間距離Ｌ1(n)との比較を行い、現在の車間距離Ｌ1(n)が先先行車が存在する場合の安全車間距離ＬＫ2以下であるとき、前述のステップS113で警報装置４に警報信号を出力してルーチンを抜ける。

【００３６】このように、本形態によれば、先行車の異常な急停止を考慮して過大な安全車間距離を設定せずとも、先行車の前方に先先行車が存在し、先行車のドライバが先先行車との車間距離を十分取らずに先先行車に異常接近し、急ブレーキをかける、あるいは、衝突寸前でハンドル操作により衝突を回避するような事態が予想される場合、予め安全な車間距離を取らせることができ、思わぬ事故を未然に回避することができる。

【００３７】図５は本発明の実施の第２形態に係わる衝突防止処理のフローチャートである。本形態は、先先行車の存在を認識できても正確な測距ができないような状況において、先行車を運転するドライバが先先行車に対する異常接近回避のための減速を行うまでの危険認識の遅れによる空走時間を考慮し、安全車間距離を算出するものである。

【００３８】すなわち、先行車が大型トラック等の場合など、ＣＣＤカメラ１０ａ，１０ｂの撮像範囲が限定される場合、先行車の更に前方の先先行車を認識できるのは、左右のカーブを走行するとき、また、自車、先行車、先先行車が左右に偏走行する等して位置関係がずれ＊たとき等である。

【００３９】従って、走行状況によっては先先行車の存在を認識できても先先行車との正確な距離を測定できない場合もあり、このような状況に対処するため、先先行車が検出されない場合の安全車間距離に対し、先先行車が検出された場合の安全車間距離を、先先行車との車間距離Ｌ2を用いることなく（必然的に先先行車速度Ｖ2も用いない）、先先行車の存在を考慮した別の値とする。

【００４０】このため、図５に示す本形態の衝突防止処理では、第１形態の衝突防止処理（図３参照）に対し、先先行車が検出された場合のステップS109, S110, S111, S112の処理を、ステップS201, 202の処理に変更しており、以下、変更部分のみについて説明する。

【００４１】すなわち、ステップS101～S106を経て先先行車が検出された場合、ステップS106からステップS201へ分岐し、自車速度Ｖ0(n)及び先行車速度Ｖ1(n)を用い、先先行車の存在を考慮した安全車間距離ＬＫ3を以下の(5)式で算出する。

【００４２】

$$LK3 = -V1(n)^2 / (2 \cdot \alpha k12) + (V0(n)^2 / (2 \cdot \alpha k0) + V0(n) \cdot (T1 + T2) + L0 \cdots (5)$$

※置４に警報信号を出力してルーチンを抜ける。

【００４５】本形態では、先行車を運転するドライバが先先行車との車間距離を十分に取らず急ブレーキをかけたときでも、予め、先行車のドライバの危険認識の遅れを考慮して車間距離を十分に取らせておくことができ、前述の第１形態と同様、思わぬ事故を未然に回避することができる。

【００４６】図６は本発明の実施の第３形態に係わる衝突防止処理のフローチャートである。本形態は、先行車に対する自車のドライバの思い込みによる認識遅れや判断遅れを考慮し、先行車の加速状態に応じて安全車間距離を設定するものである。

【００４７】図６に示す本形態の衝突防止処理では、第１形態の衝突防止処理（図３参照）のステップS101～S105と同様のステップS301～S305を経て現在の先行車速度Ｖ1(n)を算出すると、ステップS306で現在の先行車速度Ｖ1(n)と前回の先行車速度Ｖ1(n-1)とから先行車の加速度α1(n)を以下の(6)式で算出する。

【００４８】

$$\alpha 1(n) = (V1(n-1) - V1(n)) / \Delta t \quad \cdots (6)$$

次いで、ステップS307へ進み、現在の先行車加速度α1(n)が設定値αS以下か否かを調べる。この設定値αSは先行車が加速した後の挙動変更によって危険が予想されることに対処するものであり、α1(n)≦αSのときには、上記ステップS307からステップS308へ進んで第１形態で説明した先先行車が検出されないときの安全車間距離ＬＫ1を(2)式に従って算出する。

【００４９】そして、上記ステップS308からステップS309へ進み、第１形態と同様、安全車間距離ＬＫ1と現在の車間距離Ｌ1(n)とを比較し、現在の車間距離Ｌ1(n)が安全車間距離ＬＫ1より大きいときにはステップS301へ戻り、現在の車間距離Ｌ1(n)が安全車間距離ＬＫ1以下であるとき、ステップS312で警報装置４に警報信号を出力してルーチンを抜ける。

【００５０】一方、上記ステップS307でα1(n)＞αSのときには、上記ステップS307からステップS310へ分岐

し、先行車の加速後の急減速を想定した安全車間距離ＬＫ4を以下の(7)式で算出する。

$$LK4 = -V1(n)^2 / (2 \cdot \alpha k13) + (V0(n)^2 / (2 \cdot \alpha k0) + V0(n) \cdot (T1 + \Delta T) + L0 \cdots (7)$$

上記(6)式におけるΔＴは、自車のドライバの思い込みを考慮した空走時間の増分であり、先行車が加速すると、これにつられて先行車前方の状況を確認しないまま加速をするような場合の安全だという思い込みによる危険認識の遅れ、あるいは、先行車が最初は直進するつもりで加速し、急に右折しようとして対向車に対して急ブレーキをかけるような場合のブレーキ操作の遅れを想定し、先行車が速度Ｖ1(n)から減速度αk13で制動を加えたときの制動距離$V1(n)^2$／（２・αk13）、自車が速度Ｖ0から減速度αk0で制動したときの制動距離（$V0(n)^2$／（２・αk0）、空走時間Ｔ1に思いこみによる遅れを考慮した増分ΔＴを加えた自車の空走距離“Ｖ0(n)・（Ｔ1＋ΔＴ）”に基づいて安全車間距離を算出する。

【００５２】尚、上記増分ΔＴは、先行車速度Ｖ1(n)、自車速度Ｖ0(n)、先行車加速度α1(n)等の値に応じて変化させても良く、また、上記増分ΔＴに代えて先行車の減速度αk13を大きくしても良い。

【００５３】そして、上記ステップS310で安全車間距離ＬＫ4を算出した後、ステップS311へ進み、安全車間距離ＬＫ4と現在の車間距離Ｌ1(n)とを比較し、現在の車間距離Ｌ1(n)が安全車間距離ＬＫ4より大きいときには、ステップS301へ戻り、現在の車間距離Ｌ1(n)が安全車間距離ＬＫ4以下であるとき、ステップS312で警報装置４に警報信号を出力してルーチンを抜ける。

【００５４】本形態は、先行車の急ブレーキ前に予め確実な車間距離を取らせておくことができ、特に、先行車との車間距離が短く、思い込みによる事故の起こりやすい発進時や低速時に効果的である。

【００５５】尚、以上の各形態においては、２台のステレオカメラで撮像した画像を処理して先行車や先先行車等を認識する例について説明したが、２台のステレオカメラに代えて、スキャン式レーザ・レーダ、あるいは、このスキャン式レーザ・レーダと単眼のカメラとの組み合わせにより、先行車、先先行車等を認識するようにし※

＊【００５１】

※ても良い。

【００５６】

【発明の効果】以上説明したように本発明によれば、自車両の進行方向に存在する先行車と自車両との車間距離を算出し、この車間距離を、先行車と先行車の前方状況とを考慮して算出した自車両と先行車との安全車間距離と比較して自車両の衝突可能性を判断するため、先行車や先行車前方の先先行車等の複数の障害物を総合的に考慮して安全性を確保し、衝突の危険を未然に回避させた上に運転者の違和感を排除し、さらに交通の流れの妨げとならない車両運行を行うことができる等優れた効果が得られる。

【図面の簡単な説明】

【図１】本発明の実施の第１形態に係わり、衝突防止装置の概略構成図

【図２】同上、衝突防止装置の回路ブロック図

【図３】同上、衝突防止処理のフローチャート

【図４】同上、先先行車と先行車と自車との関係を示す説明図

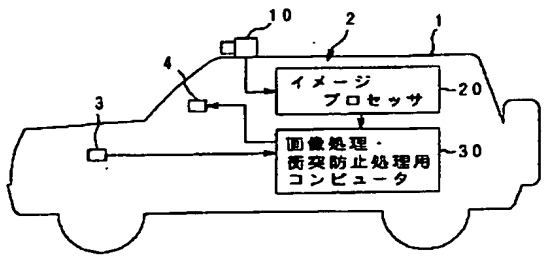
【図５】本発明の実施の第２形態に係わる衝突防止処理のフローチャート

【図６】本発明の実施の第３形態に係わる衝突防止処理のフローチャート

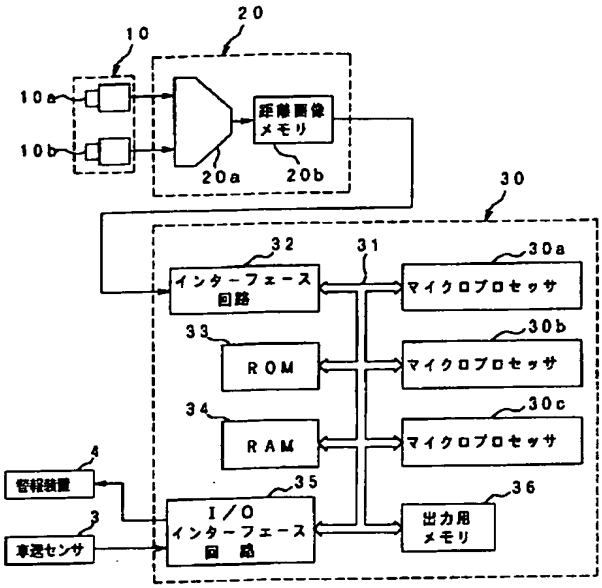
【符号の説明】

１　…車両
２　…衝突防止装置
３　…車速センサ
４　…警報装置
１０…ステレオ光学系
２０…イメージプロセッサ
３０…画像処理・衝突防止処理用コンピュータ
Ｌ1 …車間距離
Ｌ2 …自車と先先行車との車間距離
ＬＫ1, ＬＫ2, ＬＫ3, ＬＫ4…安全車間距離

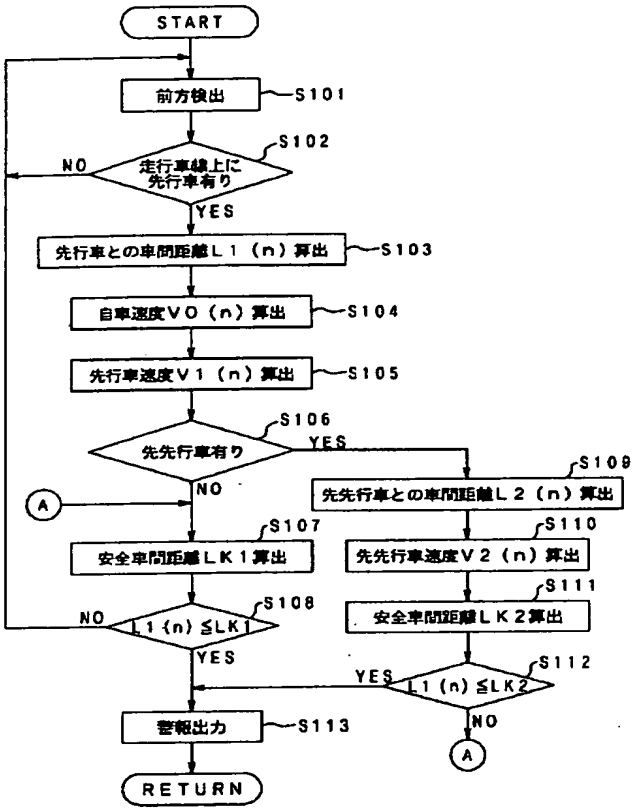
【図１】



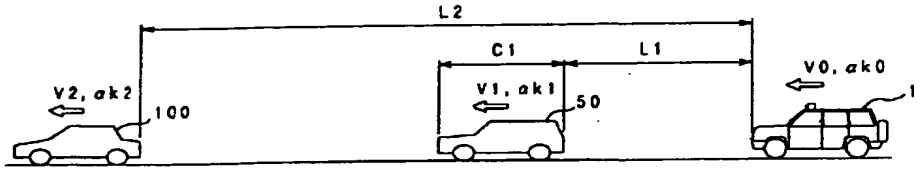
【図２】


10
20
10a
10b
距離画像メモリ
20a
20b
30
32
31
30a
インターフェース回路
マイクロプロセッサ
33
30b
ROM
マイクロプロセッサ
34
30c
RAM
マイクロプロセッサ
4
警報装置
35
36
I／O インターフェース回路
出力用メモリ
3
車速センサ

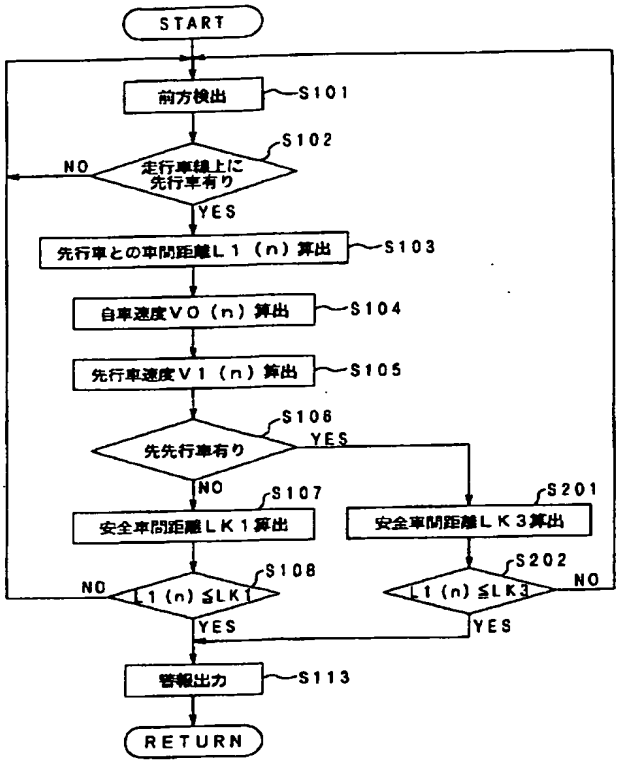
【図３】


START
前方検出
S101
S102
走行車線上に先行車有り
NO
YES
先行車との車間距離Ｌ１（ｎ）算出
S103
自車速度Ｖ０（ｎ）算出
S104
先行車速度Ｖ１（ｎ）算出
S105
S106
先先行車有り
YES
NO
S109
先先行車との車間距離Ｌ２（ｎ）算出
A
S107
安全車間距離ＬＫ１算出
S110
先先行車速度Ｖ２（ｎ）算出
S111
安全車間距離ＬＫ２算出
S108
NO
Ｌ１(ｎ)≦ＬＫ１
YES
S112
YES
Ｌ１(ｎ)≦ＬＫ２
NO
A
警報出力
S113
RETURN

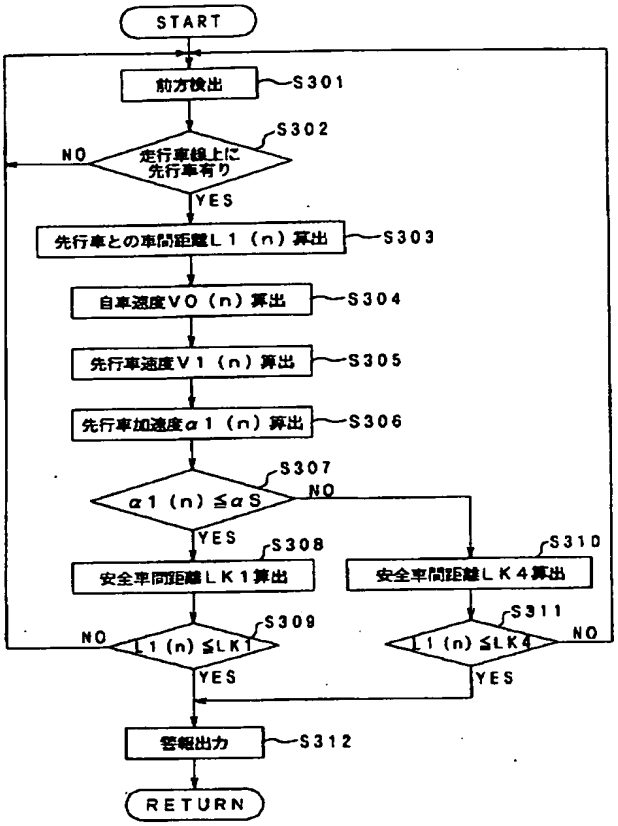
【図４】


L2
C1
L1
V2, ak2
100
V1, ak1
50
V0, ak0
1

【図５】


START
前方検出
S101
S102
NO
走行車線上に先行車有り
YES
先行車との車間距離Ｌ１（ｎ）算出
S103
自車速度ＶＯ（ｎ）算出
S104
先行車速度Ｖ１（ｎ）算出
S105
S106
先先行車有り
YES
NO
S107
安全車間距離ＬＫ１算出
S201
安全車間距離ＬＫ３算出
S108
NO
Ｌ１（ｎ）≦ＬＫ１
YES
S202
Ｌ１（ｎ）≦ＬＫ３
NO
YES
警報出力
S113
RETURN

【図６】


START
前方検出
S301
S302
NO
走行車線上に先行車有り
YES
先行車との車間距離Ｌ１（ｎ）算出
S303
自車速度ＶＯ（ｎ）算出
S304
先行車速度Ｖ１（ｎ）算出
S305
先行車加速度α１（ｎ）算出
S306
S307
α１（ｎ）≦αＳ
NO
YES
S308
安全車間距離ＬＫ１算出
S310
安全車間距離ＬＫ４算出
S309
NO
Ｌ１（ｎ）≦ＬＫ１
S311
Ｌ１（ｎ）≦ＬＫ４
NO
YES
YES
警報出力
S312
RETURN

【公報種別】特許法第１７条の２の規定による補正の掲載
【部門区分】第２部門第５区分
【発行日】平成16年10月21日(2004.10.21)

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Ｂ６０Ｒ　21/00
【ＦＩ】
Ｂ６０Ｒ　21/00　　６２０Ｚ

【手続補正書】
【提出日】平成15年10月24日(2003.10.24)
【手続補正１】
【補正対象書類名】明細書
【補正対象項目名】特許請求の範囲
【補正方法】変更
【補正の内容】
【特許請求の範囲】
【請求項１】
自車両の進行方向に存在する先行車と自車両との車間距離を算出する手段と、
上記先行車と上記先行車の前方状況とを考慮して自車両と上記先行車との安全車間距離を算出する手段と、
上記車間距離と上記安全車間距離とを比較し、自車両の衝突可能性を判断する手段とを備えたことを特徴とする車両の衝突防止装置。
【請求項２】
上記安全車間距離を、自車両と上記先行車の前方に存在する物体との距離に基づいて算出することを特徴とする請求項１記載の車両の衝突防止装置。
【請求項３】
上記安全車間距離を、上記先行車の前方状況に対する危険認識の遅れによる空走時間を想定して算出することを特徴とする請求項１記載の車両の衝突防止装置。
【請求項４】
上記安全車間距離を、上記先行車の加速状態に応じて算出することを特徴とする請求項１記載の車両の衝突防止装置。
【請求項５】
上記安全車間距離は、自車両と上記先行車との車間距離に基づいて算出した第１の安全車間距離と、自車両と上記先行車の前方に存在する物体との距離に基づいて算出した第２の安全車間距離とからなり、
上記衝突可能性を判断する手段は、上記第１の安全車間距離と上記第２の安全車間距離との少なくとも一方と上記先行車との車間距離とを比較して、自車両の衝突可能性を判断することを特徴とする請求項１記載の車両の衝突防止装置。
【手続補正２】
【補正対象書類名】明細書
【補正対象項目名】０００９
【補正方法】変更
【補正の内容】
【０００９】
請求項２記載の発明は、請求項１記載の発明において、上記安全車間距離を、自車両と上記先行車の前方に存在する物体との距離に基づいて算出することを特徴とする。

【手続補正３】
【補正対象書類名】明細書
【補正対象項目名】００１１
【補正方法】変更
【補正の内容】
【００１１】
請求項４記載の発明は、請求項１記載の発明において、上記安全車間距離を、上記先行車の加速状態に応じて算出することを特徴とする。
請求項５記載の発明は、請求項１記載の発明において、上記安全車間距離は、自車両と上記先行車との車間距離に基づいて算出した第１の安全車間距離と、自車両と上記先行車の前方に存在する物体との距離に基づいて算出した第２の安全車間距離とからなり、上記衝突可能性を判断する手段は、上記第１の安全車間距離と上記第２の安全車間距離との少なくとも一方と上記先行車との車間距離とを比較して、自車両の衝突可能性を判断することを特徴とする。
【手続補正４】
【補正対象書類名】明細書
【補正対象項目名】００１３
【補正方法】変更
【補正の内容】
【００１３】
その際、安全車間距離を自車両と先行車の前方に存在する物体との距離に基づいて算出しても良く、また、先行車の前方状況に対する危険認識の遅れによる空走時間を想定して算出しても良い。さらには、先行車の加速状態に応じて安全車間距離を算出しても良い。また、安全車間距離を、自車両と先行車との車間距離に基づいて算出した第１の安全車間距離と、自車両と先行車の前方に存在する物体との距離に基づいて算出した第２の安全車間距離とからなる安全車間距離とし、第１の安全車間距離と第２の安全車間距離との少なくとも一方と先行車との車間距離とを比較して自車両の衝突可能性を判断するようにしても良い。

PATENT ABSTRACTS OF JAPAN

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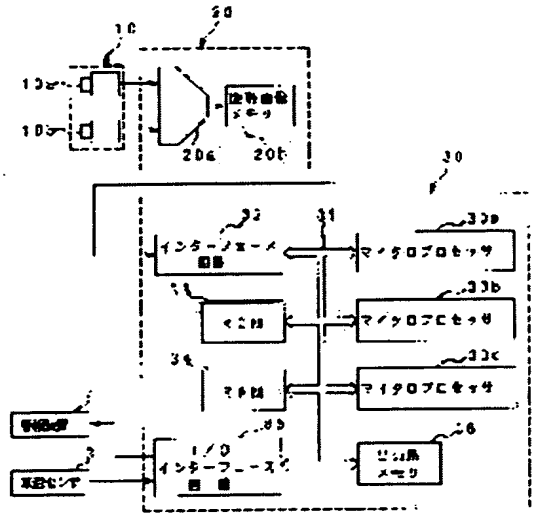
(54) COLLISION PREVENTING DEVICE FOR VEHICLE

(57)Abstract:
PROBLEM TO BE SOLVED: To prevent the risk of a collision by providing means for comparing the distance between cars with the safety distance between cars and judging the possibility of collision of own car.
SOLUTION: In the collision preventing processing by a microprocessor 30c, the safety distance between own car and the preceding car is calculated, and when the distance between the own car and the preceding car becomes less than the safety distance between cars, warning is output to a warning device 4. Further, in the case where the next ahead car to the preceding car exists in front of the receding car, in consideration of the distance between the own car and the next ahead car and the relative speed, the safety distance between the own car and the preceding car is calculated, and when the distance between the own car and the preceding car becomes less than the safety distance between the cars, a warning is output to the warning device 4 to give a warning to a driver. By promoting the operation of a brake, the safety to a sudden behavior change of the preceding car due to the existence of the next ahead car can be ensured.



* NOTICES *

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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1]A collision avoidance system of vehicles characterized by comprising the following.
A means to compute the distance between two cars of a preceded vehicle and self-vehicles which exist in a direction of movement of self-vehicles.
A means to compute the safe distance between two cars of self-vehicles and the above-mentioned preceded vehicle in consideration of a front situation of the above-mentioned preceded vehicle and the above-mentioned preceded vehicle.
A means to compare the above-mentioned distance between two cars with the above-mentioned safe distance between two cars, and to judge the collision possibility of self-vehicles.

[Claim 2]A collision avoidance system of the vehicles according to claim 1 computing the above-mentioned safe distance between two cars on the basis of distance of self-vehicles and an object which exists ahead of the above-mentioned preceded vehicle.
[Claim 3]A collision avoidance system of the vehicles according to claim 1 computing the above-mentioned safe distance between two cars supposing free running time by delay in dangerous recognition over a front situation of the above-mentioned preceded vehicle.
[Claim 4]A collision avoidance system of the vehicles according to claim 1 computing the above-mentioned safe distance between two cars according to an acceleration state of the above-mentioned preceded vehicle.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the collision avoidance system of the vehicles which detect the obstacle which exists in the advance on the street of self-vehicles, and perform a collision judgment.
[0002]
[Description of the Prior Art]These days, carry a TV camera, a laser radar, etc. in a car, and front vehicles and obstacle are detected, . Judge the danger which collides with them, emit an alarm to a driver, or operate a brake to him automatically, and stop him. Or development of the art concerning ASV (Advanced Safety Vehicle; advanced safety vehicle) of fluctuating a travel speed automatically so that the distance between two cars with a preceded vehicle may be kept safe is furthered positively.
[0003]As an example of the collision avoidance system in such ASV, To vehicle technology Vol.43 and No.2-1989.P.65-P.73 "the rear-end collision prevention alarm equipment for heavy-duty trucks." Based on the distance between two cars of the self-vehicles and precedence vehicles which were detected with the vehicle speed and the laser radar device of self-vehicles, The safe distance between two cars which computes preceded vehicle speed, the relative velocity of self-vehicles and precedence vehicles, etc., and is computed based on self-vehicles speed with this relative velocity is switched, and the art which emits an alarm is indicated noting that there is danger of a rear-end collision, when the above-mentioned distance between two cars sinks below the above-mentioned safe distance between two cars.
[0004]
[Problem(s) to be Solved by the Invention]However, conventionally, only in consideration of the preceded vehicle and obstacle of a self-vehicle front, danger is judged like the above-mentioned advanced technology, and the situation further ahead of a preceded vehicle is not taken into consideration.
[0005]For this reason, when the case where an extreme quick stop -- a preceded vehicle collides with a stop object -- is performed in consideration of absolute safety is assumed, it is necessary to emit an alarm by the always very big distance between two cars, and there are problems, such as becoming the hindrance of smooth traffic from requiring the very big distance between two cars of a driver.
[0006]When a preceded vehicle always generates an alarm on the assumption that an action with validity is taken, to the belief etc. which gazed only at the action of a driver's preceded vehicle, there is a problem that improvement in the safety beyond it cannot be aimed at.
[0007]This invention by having been made in light of the above-mentioned circumstances, and judging the synthetic situation where two or more obstacles, such as a preceded vehicle and a point preceded vehicle ahead of a preceded vehicle, were taken into consideration, The danger of the collision was made to avoid beforehand, and also a driver's sense of incongruity is eliminated, and it aims at providing the collision avoidance system of the vehicles which can perform vehicles operation used as the hindrance of the flow of traffic further.
[0008]

[Means for Solving the Problem]A means by which the invention according to claim 1 computes the distance between two cars of a preceded vehicle and self-vehicles which exist in a direction of movement of self-vehicles, A means to compute the safe distance between two cars of self-vehicles and the above-mentioned preceded vehicle in consideration of a front situation of the above-mentioned preceded vehicle and the above-mentioned preceded vehicle was compared with the above-mentioned distance between two cars and the above-mentioned safe distance between two cars, and it had a means to judge the collision possibility of self-vehicles.
[0009]The invention according to claim 2 computes the above-mentioned safe distance between two cars in the invention according to claim 1 on the basis of distance of self-vehicles and an object which exists ahead of the above-mentioned preceded vehicle.
[0010]The invention according to claim 3 computes the above-mentioned safe distance between two cars in the invention according to claim 1 supposing free running time by delay in dangerous recognition over a front situation of the above-mentioned preceded vehicle.
[0011]The invention according to claim 4 computes the above-mentioned safe distance between two cars in the invention according to claim 1 according to an acceleration state of the above-mentioned preceded vehicle.
[0012]That is, the collision possibility of self-vehicles is judged as compared with the safe distance between two cars of self-vehicles and a preceded vehicle which computed the distance between two cars of a preceded vehicle and self-vehicles which exist in a direction of movement of self-vehicles, and computed this distance between two cars in consideration of a front situation of a preceded vehicle and a preceded vehicle.
[0013]In that case, the safe distance between two cars may be computed on the basis of distance of self-vehicles and an object which exists ahead of a preceded vehicle, and it may compute supposing free running time by delay in dangerous recognition over a front situation of a preceded vehicle. The safe distance between two cars may be computed according to an acceleration state of a preceded vehicle.
[0014]
[Embodiment of the Invention]Hereafter, an embodiment of the invention is described with reference to drawings. Drawing 1 - drawing 4 are explanatory views in which the outline lineblock diagram of a collision avoidance system and drawing 2 show the circuit block figure of a collision avoidance system, drawing 3 shows the flow chart of collision-prevention processing, and drawing 4 shows the relation between a point preceded vehicle, a preceded vehicle, and a self-vehicle as for drawing 1 with respect to the 1st gestalt of operation of this invention.
[0015]The obstacle which the numerals 1 are vehicles, such as a car, and exists in these vehicles 1 in drawing 1 in a direction of movement, When precedence vehicles, the future line vehicles which exist ahead of these precedence vehicles, etc. are recognized, the danger of a collision is judged and there is danger of a collision, the collision avoidance system 2 which emits the alarm of collision avoidance and ensures safety is carried.
[0016]The stereo optical system 10 for picturizing the subject outside a car from a different position in the above-mentioned collision avoidance system 2 and one pair of pictures picturized by this stereo optical system 10 are processed, Process the image processor (based on what is called a stereo method) 20 which computes the three-dimensional distance distribution over the whole picture by the principle of triangulation from the azimuth difference to the same object, and the distance distribution data from this image processor 20, and road geometry and two or more solid things are recognized, It has image processing and the computer 30 for collision-prevention processing which outputs a conflict alert when the safety to two or more obstacles, such as a preceded vehicle and a point preceded vehicle ahead of a preceded vehicle, is judged synthetically and there is danger of a collision, While the sensor for detecting the run state of the present vehicles of speed sensor 3 grade is connected to described image processing and the computer 30 for collision-prevention processing, the alarm equipment 4 which consists of a buzzer or a display is connected.
[0017]As shown in drawing 2, the above-mentioned stereo optical system 10, For example, it is constituted by CCD cameras 10a and 10b of 1 set of right and left using solid state image pickup devices, such as a charge coupled device (CCD), and these cameras 10a and 10b, As shown in

drawing 1, it is installed ahead on the roof of the vehicles 1, and an imaging visual field is expanded to further the front of not only the self-vehicle front but a preceded vehicle, so that front recognition of a preceded vehicle may become easy.

[0018]The above-mentioned image processor 20 searches for the portion to which the same object is reflected for every infinitesimal area to the stereo image pair of two sheets picturized by the above-mentioned stereo optical system 10, It comprises the distance detection circuit 20a which computes the distance to an object in quest of the amount of gaps of a corresponding position, and the depth map memory 20b which memorizes the distance distribution data (depth map) which carried out a gestalt like the picture which is an output of this distance detection circuit 20a.

[0019]Described image processing and the computer 30 for collision-prevention processing, The microprocessor 30a which performs processing which mainly detects road geometry, The microprocessor 30b which performs processing which mainly detects each solid thing, and the microprocessor 30c which judges near collision nature mainly from the distance between two cars of a self-vehicle and a preceded vehicle serve as a system configuration of the multimicroprocessor connected in parallel via the system bath 31.

[0020]In the above-mentioned system bath 31. The I/O interface circuit 35 where the interface circuit 32 connected to the above-mentioned depth map memory 20b, ROM33 which store a control program, RAM34 which memorize the various parameters in the middle of computation, the above-mentioned speed sensor 3, and the above-mentioned alarm equipment 4 are connected, The memory 36 grade for an output which memorizes the parameter of a processing result is connected.

[0021]In the road detection processing by the above-mentioned microprocessor 30a. The parameter of the road model which dissociated, and extracted and built in only the white line on a actual road using the three-dimensional position information by the depth map memorized by the depth map memory 20b is corrected and changed so that it may agree with actual road geometry, and road geometry is recognized.

[0022]In the object detection processing by the above-mentioned microprocessor 30b. Classify a depth map into the shape of a lattice at the predetermined intervals, and only the data of the solid thing which may become an obstacle of a run is sorted out for every field, The detection distance is computed, when the difference in the detection distance to an object is below a preset value in an adjoining field, it is regarded as the same object, and on the other hand, in beyond a preset value, it is regarded as a separate object, and the contour image of the detected object is extracted.

[0023]About generation of the depth map by the above image processor 20, and the processing which detects road geometry and an object from the depth map by the above-mentioned microprocessors 30a and 30b. It is explained in full detail by JP,5-265547,A, JP,6-177236,A, etc. which were previously submitted by these people.

[0024]In the collision-prevention processing by the above-mentioned microprocessor 30c. When the safe distance between two cars of a self-vehicle and a preceded vehicle is computed and the distance between two cars of a self-vehicle and a preceded vehicle turns into below the safe distance between two cars, When a point preceded vehicle exists in the alarm equipment 4 ahead of a preceded vehicle in addition to the usual processing which outputs an alarm, When the safe distance between two cars of a self-vehicle and a preceded vehicle is computed in consideration of the distance between two cars and relative velocity of a self-vehicle and a point preceded vehicle and the distance between two cars of a self-vehicle and a preceded vehicle turns into below the safe distance between two cars, An alarm is outputted to the alarm equipment 4 and the safety to the rapid behavior variation of the preceded vehicle by existence of a point preceded vehicle is secured by urging operation of a brake in which emit warning and it is not illustrated to a driver. It is also possible to make it the automatic brake device etc. which are not illustrated interlocked with, and to output an active signal.

[0025]Hereafter, the collision-prevention processing concerning this invention is explained according to the flow chart of drawing 3 among processings by described image processing and the computer 30 for collision-prevention processing. In the following explanation, as for a point

preceded vehicle, although the relation of a self-vehicle, the preceded vehicle which runs the self-vehicle front, and the point preceded vehicle of this preceded vehicle which runs the front further is explained, it is good like the pedestrian under parking vehicles and crossing not to be necessarily a traveling vehicle.

[0026]In this program, the data of two or more solid things extracted from the depth map first produced by picturizing the running direction of a self-vehicle at Step S101 is read, and it is investigated whether a preceded vehicle is on the slow lane at Step S102. As a result, when there is no preceded vehicle on running lines, it returns to the above-mentioned step S101, and when a preceded vehicle is on the slow lane, the distance between two cars L1 of a preceded vehicle and a self-vehicle (n) is computed by progressing to Step S103. The storage update of the value memorized until now is carried out as the last distance between two cars L1 (n-1). The subscript (n) of each parameter ** expresses hereafter the value calculated this time, and a subscript (n-1) expresses the value calculated last time.

[0027]Next, progress to Step S104, compute the self-vehicle speed V0 based on the signal from the speed sensor 3, and at Step S105. Based on the temporal change and the present self-vehicle speed V0 (n) of this distance between two cars L1 (n) and the last distance between two cars L1 (n-1), the preceded vehicle speed V1 (n) is computed by the following (1) formulas.

[0028]

V1(n) =(L1(n)-L1 (n-1))/deltat+V0 (n) --(1), however deltat: Measurement and after that [operation cycle], progress to Step S106 and investigate whether a point preceded vehicle exists ahead of a preceded vehicle from the data of two or more solid things extracted from the depth map. As a result, when a point preceded vehicle does not exist, it progresses to Step S107 from the above-mentioned step S106, and safe distance-between-two-cars LK1 of a preceded vehicle and a self-vehicle is computed.

[0029]As for this safe distance-between-two-cars LK1, a preceded vehicle is deceleration (deceleration; however) from the speed V1 (n). The brake stopping distance "$V1(n)^2/(2-alphak11)$" at the time of assuming that braking was added by alphak11 which shows an absolute value hereafter unless it mentions specially, a brake stopping distance when a self-vehicle brakes with the decelerated velocity alphak0 from the speed V0 -- " (based on $V0(n)^2/(2-alphak0)$", computed by the following (2) formulas.)

[0030]

$LK1=-V1(n)^2/(2-alphak11)+(V0(n)^2/(2-alphak0))$ + V0(n) and T1+L0 --(2), however free running time L0 of a T1:self-vehicle : distance margin (interval after a stop)

The value of the deceleration alphak0 which sets up beforehand the value of the deceleration alphak11 which defines the brake stopping distance of the preceded vehicle in the above-mentioned (2) formula here supposing the state where the preceded vehicle hung the slam on the brake, for example, and defines the brake stopping distance of a self-vehicle is set up in consideration of the stop ability of a self-vehicle, etc. The value of the distance margin L0 which serves as a margin of the distance between two cars to the free running time T1 in consideration of the reaction time of the driver, For example, it is so desirable to take the large distance margin L0 that the deceleration of a preceded vehicle is large when it may set up according to the acceleration of a preceded vehicle and the acceleration of a preceded vehicle is in a deceleration state by negative.

[0031]And if safe distance-between-two-cars LK1 is computed at the above-mentioned step S107, it progresses to Step S108 and this safe distance-between-two-cars LK1 is compared with the present distance between two cars L1 (n). As a result, when the present distance between two cars L1 (n) returns from the above-mentioned step S108 to the above-mentioned step S101 when larger than safe distance-between-two-cars LK1, and the present distance between two cars L1 (n) is one or less safe distance-between-two-cars LK, It is judged as those of a collision with danger, it progresses to Step S113 from the above-mentioned step S108, and an alarm signal is outputted to the alarm equipment 4 in order to urge operation of a brake in which emit warning and it is not illustrated to a driver, and it escapes from a routine.

[0032]On the other hand, at the above-mentioned step S106, when a point preceded vehicle exists, When it branches from the above-mentioned step S106 to Step S109 and the distance between two cars L2 of a self-vehicle and a point preceded vehicle (n) is computed, at Step S110. Based on the temporal change and the present self-vehicle speed V0 (n) of this distance between two cars L2 (n) and the last distance between two cars L2 (n-1), the future line vehicle speed V2 (n) is computed by the following (3) formulas.

[0033]

V2(n) =(L2(n)-L2 (n-1))/deltat+V0 (n) -- (3) After that, progress to Step S111 and compute safe distance-between-two-cars LK2 of the self-vehicle and preceded vehicle in consideration of existence of a point preceded vehicle. In namely, the situation where the preceded vehicle 50 exists ahead of the self-vehicle 1, and the point preceded vehicle 100 exists ahead of this preceded vehicle 50 further as shown in drawing 4. . The driver of the preceded vehicle 50 near-misses with the point preceded vehicle 100, without taking enough the distance between two cars with the point preceded vehicle 100, and slams the brake. Or are just before a collision and a case as the collision was avoided by handle operation is assumed, As opposed to safe distance-between-two-cars LK1 of the self-vehicle and preceded vehicle by the above-mentioned (2) types, The brake stopping distance "$V1(n)^2/(2-alphak11)$" by the deceleration alphak11 from the speed V1 of the preceded vehicle 50 (n), It transposes to the brake stopping distance "$V2(n)^2/(2-alphak2)$" by the deceleration alphak2 from the speed V2 of the point preceded vehicle 100 (n), and safe distance-between-two-cars LK2 of the self-vehicle 1 in case the point preceded vehicle 100 exists, and the preceded vehicle 50 is computed by the following (4) formulas.

[0034]

$LK2=-V2(n)^2/(2-alphak2)+(V0(n)^2/(2-alphak0))$
$+V0(n)-T1+L0+C1$ -- (4), however the outside length of car body of a C1:preceded vehicle -- the paragraph of the brake stopping distance "$V2(n)^2/(2-alphak2)$" in the above-mentioned (4) formula in this case, The object detected ahead of the preceded vehicle is set to 0 at the times, such as not a traveling vehicle but parking vehicles, and a pedestrian, " (according to the present self-vehicle speed V0 (n), the deceleration alphak2 of a self-vehicle is set up so that the paragraph of $V0(n)^2/(2-alphak0)+V0(n)$ and T1+L0+C1" may become below in the distance L2 from a self-vehicle to the object ahead of a preceded vehicle (n).)

[0035]Subsequently, safe distance-between-two-cars LK2 in case it progresses to Step S112 from the above-mentioned step S111 and a point preceded vehicle exists is compared with the present distance between two cars L1 (n), The present distance between two cars L1 (n) when larger than safe distance-between-two-cars LK2, Comparison with safe distance-between-two-cars LK1 in case it jumps to the above-mentioned step S107 and a point preceded vehicle does not exist, and the present distance between two cars L1 (n) is performed, When the present distance between two cars L1 (n) is two or less safe distance-between-two-cars LK in case a point preceded vehicle exists, an alarm signal is outputted to the alarm equipment 4 at the above-mentioned step S113, and it escapes from a routine.

[0036]Thus, according to this gestalt, in consideration of the unusual quick stop of a preceded vehicle, do not set up the excessive safe distance between two cars, but **, . A point preceded vehicle exists ahead of a preceded vehicle, and the driver of a preceded vehicle near-misses with a point preceded vehicle, without taking enough the distance between two cars with a point preceded vehicle, and slams the brake. Or when the situation where it is just before a collision and a collision is avoided by handle operation is expected, it can be beforehand made to take the safe distance between two cars, and an unexpected accident can be avoided beforehand.

[0037]Drawing 5 is a flow chart of the collision-prevention processing concerning the 2nd gestalt of operation of this invention. In the situation which cannot perform exact ranging even if it can recognize existence of a point preceded vehicle, this gestalt computes the safe distance between two cars in consideration of the free running time by the delay in dangerous recognition until it performs the slowdown for near-miss evasion of as opposed to a point preceded vehicle

in the driver who drives a preceded vehicle.
[0038]Namely, when [, such as a case of a heavy-duty truck etc.,] the imaging range of CCD cameras 10a and 10b is limited, a preceded vehicle that a front point preceded vehicle can be recognized further of a preceded vehicle, When running a curve on either side, it is a time of a self-vehicle, a preceded vehicle, and a point preceded vehicle ******(ing) right and left, and physical relationship shifting, etc.
[0039]Therefore, in order to be unable to measure an exact distance with a point preceded vehicle even if it can recognize existence of a point preceded vehicle depending on a traveling condition, and to cope with such a situation, It is considered as another value in consideration of existence of a point preceded vehicle, without using the distance between two cars L2 with a point preceded vehicle for the safe distance between two cars when a point preceded vehicle is detected to the safe distance between two cars in case a point preceded vehicle is not detected (the future line vehicle speed V2 is not used inevitably, either).
[0040]For this reason, in collision-prevention processing of this gestalt shown in drawing 5. Processing of the step S109 when a point preceded vehicle is detected, S110, S111, and S112 is changed into processing of Step S201,202 to collision-prevention processing (refer to drawing 3) of the 1st gestalt, and only a changed part is explained hereafter.
[0041]That is, when a point preceded vehicle is detected through Steps S101-S106, it branches from Step S106 to Step S201, and safe distance-between-two-cars LK3 in consideration of existence of a point preceded vehicle is computed by the following (5) formulas using the self-vehicle speed V0 (n) and the preceded vehicle speed V1 (n).
[0042]
$LK3=-V1(n)^2/(2-alphak12)+(V0(n)^2/(2-alphak0))$
+ V0 (n) -(T1+T2) +L0 — T2 in the (5) above-mentioned (5) type, The driver who drives a preceded vehicle does not fully take the distance between two cars with a point preceded vehicle, It is the free running time of the preceded vehicle by the error of judgment, the delay in dangerous recognition, etc. if the distance between two cars with a point preceded vehicle is still safe, Brake-stopping-distance $V1(n)^2$/when a preceded vehicle adds braking with the decelerated velocity alphak12 from the speed V1 (n) (2-alphak12), A brake stopping distance when a self-vehicle brakes with the decelerated velocity alphak0 from the speed V0 (the free running distance "V0(n) - (T1+T2)" of the self-vehicle by the free running time T2 of a preceded vehicle and the free running time T1 of a self-vehicle is considered to $V0(n)^2/(2-alphak0)$.)
[0043]In this case, although deceleration alphak12 of a preceded vehicle can be made comparable as the deceleration alphak11 of the preceded vehicle in calculation of safe distance-between-two-cars LK1 in case a point preceded vehicle does not exist, it may consider safety more and may enlarge it.
[0044]And after computing safe distance-between-two-cars LK3 at the above-mentioned step S201, Progress to Step S202, compare safe distance-between-two-cars LK3 with the present distance between two cars L1 (n), and the present distance between two cars L1 (n) when larger than safe distance-between-two-cars LK3, It returns to Step S101, and when the present distance between two cars L1 (n) is three or less safe distance-between-two-cars LK, an alarm signal is outputted to the alarm equipment 4 at Step S113, and it escapes from a routine.
[0045]Even when the driver who drives a preceded vehicle does not fully take the distance between two cars with a point preceded vehicle but slams the brake in this gestalt, In consideration of the delay in dangerous recognition of the driver of a preceded vehicle, it can fully be made to take the distance between two cars, and an unexpected accident can be beforehand avoided like the 1st above-mentioned gestalt.
[0046]Drawing 6 is a flow chart of the collision-prevention processing concerning the 3rd gestalt of operation of this invention. This gestalt sets up the safe distance between two cars according to the acceleration state of a preceded vehicle in consideration of the recognition delay and judgment delay by belief of a driver of the self-vehicle to a preceded vehicle.
[0047]If the present preceded vehicle speed V1 (n) is computed in collision-prevention processing of this gestalt shown in drawing 6 through Steps S101-S105 of collision-prevention

processing (refer to drawing 3) of the 1st gestalt, and the same steps S301-S305, The acceleration alpha 1 of a preceded vehicle (n) is computed by the following (6) formulas by Step S306 from the present preceded vehicle speed V1 (n) and the last preceded vehicle speed V1 (n-1).

[0048]

alpha 1 (n) =(V1(n-1)-V1 (n))/deltat It (6) --Ranks second, and progresses to Step S307, and it is investigated whether the present preceded vehicle acceleration alpha 1 (n) is below preset value alphaS. By action change after a preceded vehicle accelerates, this preset value alphaS copes with that danger is expected, and at the time of alpha1(n) <=alphaS. Safe distance-between-two-cars LK1 in case the point preceded vehicle which he followed to Step S308 from the above-mentioned step S307, and was explained with the 1st gestalt is not detected is computed according to (2) types.

[0049]And from the above-mentioned step S308, progress to Step S309 and like the 1st gestalt, When safe distance-between-two-cars LK1 is compared with the present distance between two cars L1 (n), the present distance between two cars L1 (n) returns to Step S301 when larger than safe distance-between-two-cars LK1, and the present distance between two cars L1 (n) is one or less safe distance-between-two-cars LK, An alarm signal is outputted to the alarm equipment 4 at Step S312, and it escapes from a routine.

[0050]Safe distance-between-two-cars LK4 which branched from the above-mentioned step S307 to Step S310, and, on the other hand, assumed the sudden deceleration after acceleration of a preceded vehicle at the above-mentioned step S307 at the time of alpha1(n) >alphaS is computed by the following (7) formulas.

[0051]

$LK4=-V1(n)^2/(2-alphak13)+(V0(n)^2/(2-alphak0))$
$+V0(n)-(T1+deltaT)+L0$ -- deltaT in the (7) above-mentioned (6) type, If it is the increment of the free running time in consideration of a belief of the driver of a self-vehicle and a preceded vehicle accelerates, The delay in the dangerous recognition by the belief that it is the safety of a case so that it may accelerate being hung by this and not checking the situation ahead of a preceded vehicle, Or the delay of the brakes operation of a case so that a preceded vehicle may plan to go straight on at first, may accelerate, may turn to the right suddenly and may slam the brake to an oncoming car is assumed, Brake-stopping-distance $V1(n)^2$/when a preceded vehicle adds braking with the decelerated velocity alphak13 from the speed V1 (n) (2-alphak13), A brake stopping distance when a self-vehicle brakes with the decelerated velocity alphak0 from the speed V0 (V0 (n) based on the free running distance "V0(n) - (T1+deltaT)" of the self-car which added increment deltaT in consideration of the delay by belief, the safe distance between two cars is computed to ^{2}/(2-alphak0) and the free running time T1.)

[0052]The above-mentioned increment deltaT may be changed according to values, such as the preceded vehicle speed V1 (n), the self-vehicle speed V0 (n), and the preceded vehicle acceleration alpha 1 (n), and may be replaced with the above-mentioned increment deltaT, and may enlarge deceleration alphak13 of a preceded vehicle.

[0053]And after computing safe distance-between-two-cars LK4 at the above-mentioned step S310, Progress to Step S311, compare safe distance-between-two-cars LK4 with the present distance between two cars L1 (n), and the present distance between two cars L1 (n) when larger than safe distance-between-two-cars LK4, It returns to Step S301, and when the present distance between two cars L1 (n) is four or less safe distance-between-two-cars LK, an alarm signal is outputted to the alarm equipment 4 at Step S312, and it escapes from a routine.

[0054]This gestalt can make it take the positive distance between two cars beforehand before the slam on the brake of a preceded vehicle, is especially short, and effective at the time of the start in which the accident by belief happens easily, and a low speed. [of the distance between two cars with a preceded vehicle]

[0055]Although the example which processes the picture picturized by two sets of stereo cameras in each above gestalt, and recognizes a preceded vehicle, a point preceded vehicle, etc. was explained, It replaces with two sets of stereo cameras, and may be made to recognize a

preceded vehicle, a point preceded vehicle, etc. with the combination of a scan type laser radar, or this scan type laser radar and the camera of an ocellus.

[0056]

[Effect of the Invention]As explained above, according to this invention, the distance between two cars of the preceded vehicle and self-vehicles which exist in the direction of movement of self-vehicles is computed, In order to judge the collision possibility of self-vehicles as compared with the safe distance between two cars of the self-vehicles and preceded vehicle which computed this distance between two cars in consideration of the front situation of a preceded vehicle and a preceded vehicle, Safety is secured synthetically in consideration of two or more obstacles, such as a preceded vehicle and a point preceded vehicle ahead of a preceded vehicle, the danger of the collision was made to avoid beforehand, and also a driver's sense of incongruity is eliminated, and the outstanding effect -- vehicles operation which does not serve as hindrance of the flow of traffic further can be performed -- is acquired.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]It is involved in the 1st gestalt of operation of this invention, and is an outline lineblock diagram of a collision avoidance system.
[Drawing 2]The same as the above, the circuit block figure of a collision avoidance system
[Drawing 3]The flow chart of the same as the above and collision-prevention processing
[Drawing 4]The explanatory view showing the relation between the same as the above, a point preceded vehicle, a preceded vehicle, and a self-vehicle
[Drawing 5]The flow chart of the collision-prevention processing concerning the 2nd gestalt of operation of this invention
[Drawing 6]The flow chart of the collision-prevention processing concerning the 3rd gestalt of operation of this invention
[Description of Notations]
1 — Vehicles
2 — Collision avoidance system
3 — Speed sensor
4 — Alarm equipment
10 — Stereo optical system
20 — Image processor
30 — Image processing and computer for collision-prevention processing
L1 — Distance between two cars
L2 — The distance between two cars of a self-vehicle and a point preceded vehicle
LK1, LK2, LK3, LK4 — Safe distance between two cars

[Translation done.]

* NOTICES *

CORRECTION OR AMENDMENT

[Kind of official gazette]Printing of amendment by the regulation of 2 of Article 17 of Patent Law

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[Written amendment]
[Filing date]October 24, Heisei 15 (2003.10.24)
[Amendment 1]
[Document to be Amended]Specification
[Item(s) to be Amended]Claim
[Method of Amendment]Change
[The contents of amendment]
[Claim(s)]
[Claim 1]
A means to compute the distance between two cars of a preceded vehicle and self-vehicles which exist in a direction of movement of self-vehicles,
A means to compute the safe distance between two cars of self-vehicles and the above-mentioned preceded vehicle in consideration of a front situation of the above-mentioned preceded vehicle and the above-mentioned preceded vehicle,
A collision avoidance system of vehicles provided with a means to compare the above-mentioned distance between two cars with the above-mentioned safe distance between two cars, and to judge the collision possibility of self-vehicles.
[Claim 2]
A collision avoidance system of the vehicles according to claim 1 computing the above-mentioned safe distance between two cars based on distance of self-vehicles and an object which exists ahead of the above-mentioned preceded vehicle.
[Claim 3]
A collision avoidance system of the vehicles according to claim 1 computing the above-mentioned safe distance between two cars supposing free running time by delay in dangerous recognition over a front situation of the above-mentioned preceded vehicle.
[Claim 4]
A collision avoidance system of the vehicles according to claim 1 computing the above-

mentioned safe distance between two cars according to an acceleration state of the above-mentioned preceded vehicle.
[Claim 5]
The above-mentioned safe distance between two cars consists of the 2nd safe distance between two cars computed based on the 1st safe distance between two cars computed based on the distance between two cars of self-vehicles and the above-mentioned preceded vehicle, and distance of self-vehicles and an object which exists ahead of the above-mentioned preceded vehicle,
A collision avoidance system of the vehicles according to claim 1 a means to judge the above-mentioned collision possibility comparing the distance between two cars of at least one side of the safe distance between two cars of the above 1st, and the safe distance between two cars of the above 2nd, and the above-mentioned preceded vehicle, and judging the collision possibility of self-vehicles.
[The amendment 2]
[Document to be Amended]Specification
[Item(s) to be Amended]0009
[Method of Amendment]Change
[The contents of amendment]
[0009]
The invention according to claim 2 computes the above-mentioned safe distance between two cars in the invention according to claim 1 based on the distance of self-vehicles and the object which exists ahead of the above-mentioned preceded vehicle.
[Amendment 3]
[Document to be Amended]Specification
[Item(s) to be Amended]0011
[Method of Amendment]Change
[The contents of amendment]
[0011]
The invention according to claim 4 computes the above-mentioned safe distance between two cars in the invention according to claim 1 according to the acceleration state of the above-mentioned preceded vehicle.
In the invention according to claim 1, the invention according to claim 5 the above-mentioned safe distance between two cars, The 1st safe distance between two cars computed based on the distance between two cars of self-vehicles and the above-mentioned preceded vehicle, A means to consist of the 2nd safe distance between two cars computed based on the distance of self-vehicles and the object which exists ahead of the above-mentioned preceded vehicle, and to judge the above-mentioned collision possibility, The distance between two cars of at least one side of the safe distance between two cars of the above 1st and the safe distance between two cars of the above 2nd and the above-mentioned preceded vehicle is compared, and the collision possibility of self-vehicles is judged.
[Amendment 4]
[Document to be Amended]Specification
[Item(s) to be Amended]0013
[Method of Amendment]Change
[The contents of amendment]
[0013]
In that case, the safe distance between two cars may be computed based on the distance of self-vehicles and the object which exists ahead of a preceded vehicle, and it may compute supposing the free running time by the delay in the dangerous recognition over the front situation of a preceded vehicle. The safe distance between two cars may be computed according to the acceleration state of a preceded vehicle. The 1st safe distance between two cars that computed the safe distance between two cars based on the distance between two cars of self-vehicles and a preceded vehicle,It is considered as the safe distance between two cars which consists of the 2nd safe distance between two cars computed based on the distance of self-

vehicles and the object which exists ahead of a preceded vehicle, the distance between two cars of at least one side of the 1st safe distance between two cars and the 2nd safe distance between two cars and a preceded vehicle is compared, and it may be made to judge the collision possibility of self-vehicles.

[Translation done.]